

Appendix D - Proposed and Probable Practices, Goods Produced and Other Information

The purpose of this appendix is to display an estimate of the goods and services provided, the proposed first decade and probable second decade management practices expected, and other information including land classification.

The outputs and proposed and probable practices listed are projections based on available inventory data and some are based on computer modeling. The outputs and amounts listed below are estimates only and are subject to annual budgets for funding the various resource programs on the forest. Actual amounts may vary from those predicted and will be monitored on an annual basis.

Outputs and Probable Practices

Land Classification:

Land identified as suitable for timber management include producing timber as part of multiple use direction. These are lands that contribute to the timber sale program on a regularly scheduled basis. Table D-1 shows how acres of these lands compare to the total acreage of National Forest System land on the Huron-Manistee National Forests.

Table D-1. Classification of National Forest System Land for Timber Production.

Classification	Acres
Total National Forest System land (Land Status Acres)	980,341
Non-forest and water	51,468
Legally withdrawn (Wilderness, Research Natural Area, Experimental Forests)	15,029
Land not physically suited for timber production (low site index, regeneration not assured, etc)	581
Forest Land – Inadequate Information	18,202
Land not appropriate for timber production due to other resource Management (riparian areas, campgrounds, unique areas, etc)	465,597
Land suitable for timber management	401,121

Allowable Sale Quantity:

The allowable sale quantity of timber is the maximum amount of regulated volume that may be offered and sold during a given decade of Forest Plan implementation from land identified as suitable for timber management. Table D-2 shows the mix of volumes by forest type that contribute to the allowable sale quantity (Sale Schedule).

During the first decade, the first ten years of plan implementation, the allowable sale quantity is 910.0 million board feet (1516.8 thousand cubic feet). The amount of timber that may be sold

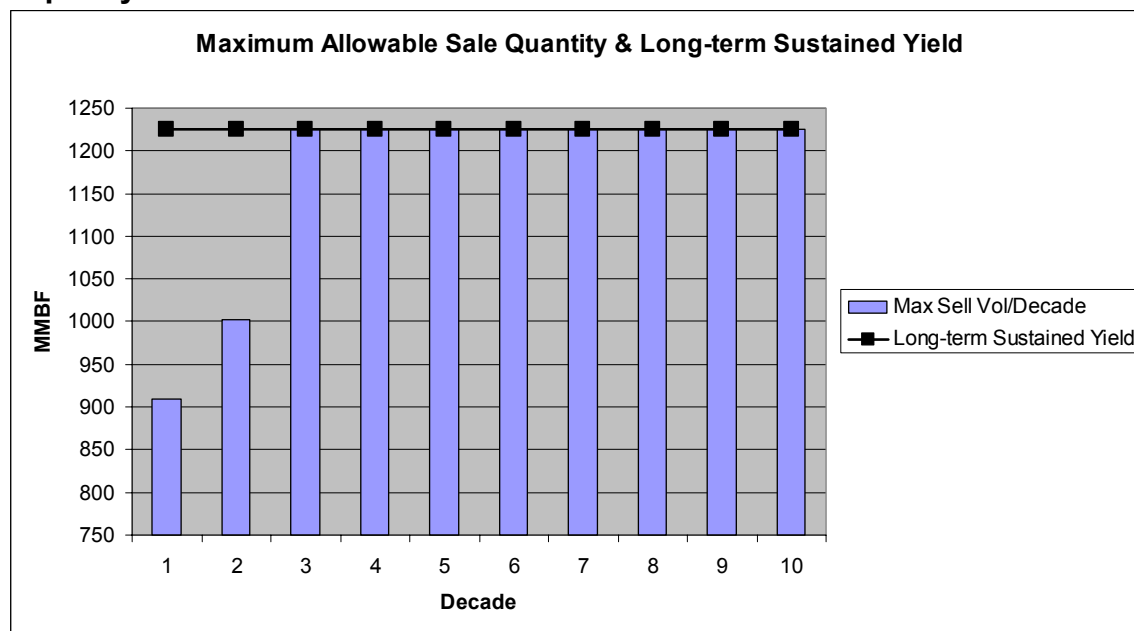
annually may exceed 91.0 million board feet as long as the decadal allowable sale quantity is not exceeded. During the second decade, the allowable sale quantity is 1,002 million board feet, or 1,671.8 thousand cubic feet. The amount of timber that may be sold annually may exceed 100.2 million board feet as long as the decadal allowable sale quantity is not exceeded.

Table D-2. Volume by Vegetation Class Breakdown on Lands Suitable for Timber Production for the First and Second Decades.

Vegetation Class	Decade 1		Decade 2	
Units	Million Board Feet	Thousand Cubic Feet	Million Board Feet	Thousand Cubic Feet
Aspen/ Birch	271	451.7	325	541.7
Short-Lived Conifer	109	181.7	176	293.3
Long-Lived Conifer	307	511.7	322	536.7
Low-Site Oak	52	86.7	1	1.7
High-Site Oak	171	285.0	106	176.7
Northern Hardwood			73	121.7
Total Million Board Feet	910.0		1,002	
Total Thousand Cubic Feet		1,516.8		1,671.8

Figure D-1 shows the volumes that can be harvested in each decade on a long-term, sustained yield basis.

Figure D-1. Maximum Allowable Sale Quantity and Long-Term Sustained Yield Capacity.



Non-Chargeable Sale Volume:

In addition, volume is sold that may come from land classified as not suitable for timber production. Volumes from these lands do not contribute to the allowable sale quantity. Management for such things as barrens, savannahs, prairies, old-growth restoration or riparian habitat managements are the primary reasons why volume is generated from these lands.

Table D-3. Volume by Vegetation Class Breakdown on Lands Not Suitable for Timber Production for the First and Second Decades.

Vegetation Class	Decade 1		Decade 2	
Units	Million Board Feet	Thousand Cubic Feet	Million Board Feet	Thousand Cubic Feet
Aspen/ Birch				
Short-Lived Conifer	21	34.9	51	85.6
Long-Lived Conifer	168	279.5	145	241.8
Low-Site Oak	19	31.6	78	129.3
High-Site Oak	43	70.9	45	74.9
Northern Hardwood				
Total Million Board Feet	250		319	
Total Thousand Cubic Feet		417.0		531.6

Proposed (Decade 1) and Probable (Decade 2) Management Practices

Silvicultural Practices:

Tables D-4 and D-5 list the proposed and probable silvicultural methods that would be used to work toward the vegetative and other multiple-use desired conditions and objectives of the Forest Plan. The tables display the projected amount of each silvicultural method for the first two decades of Forest Plan implementation based upon modeling. Actual accomplishments during Forest Plan implementation may vary from these modeled outputs.

Table D-4. Acres of Proposed and Probable Silvicultural Methods in the First and Second Decades From Lands Suitable for Timber Production.

Vegetation Class	Silvicultural Method							
	Thin		Clearcut		Shelterwood		Selection	
	Decade 1	Decade 2	Decade 1	Decade 2	Decade 1	Decade 2	Decade 1	Decade 2
Aspen/ Birch			24,100	28,000				
Short-Lived Conifer			14,166	17,923				
Long-Lived Conifer	35,432	54,512	1,634	1,096				
Low-Site Oak			5,244	77				
High-Site Oak	24,025	1,146			8,261	22,879		
Northern Hardwood								16,299
Total Decade 1	59,457		45,144		8,261			
Total Decade 2		55,658		47,096		22,879		16,299

Table D-5. Acres of Proposed and Probable Silvicultural Methods in the First and Second Decades From Lands Not Suitable for Timber Production.

Vegetation Class	Silvicultural Method							
	Create Barrens		Create Opening		OG to Barrens		OG Restoration	
Decade	1	2	1	2	1	2	1	2
Aspen/ Birch								
Short Lived Conifer	130	4,248	1,990			603		
Long Lived Conifer	4,250	5,347	5,300	1		657		6,347
Low Site Oak	794	4,823	800			1,178		
High Site Oak	2,551	2,548						
Northern Hardwood								
Total Decade 1	7,725		8,090					
Total Decade 2		16,966		1		2,438		6,347

Forest-wide Proposed Practices:

Table D-6 lists other forest management activities that are proposed to work toward the desired conditions and objectives during the first 10 years of Forest Plan implementation.

Table D-6. Proposed Practices (Forest-wide).

Activity or Practice	Definition of Activity or Practice	Unit of Measure	Average Annual Amount in the First Decade
Manage Stream Habitat	Activities include, but are not limited to, bank stabilization through placement of habitat structures; sediment reduction; and angler access improvement	Miles of stream per year	121
Manage Lake Habitat	Activities include, but are not limited to, bank stabilization through placement of habitat structures; sediment reduction; and angler access improvement	Acres per Year	240
Manage Terrestrial Habitat	Activities include but are not limited to planting, burning, cutting, fencing, nesting structures, and access management aimed at protection, restoration and enhancement of terrestrial habitats and associated desirable species, including species at risk.	Acres per Year	7,000
Manage Noxious Weeds	Prevention, treatment and monitoring of noxious weeds including activities such as biological, mechanical and chemical control.	Acres per Year	4,000
Manage Rangeland Vegetation	Activities include but are not limited to planting/seeding of desired vegetation; protection of desired vegetation, monitoring of rangeland vegetation treatments	Acres per Year	312

Table D-6. Proposed Practices (Forest-wide) (Continued).

Activity or Practice	Definition of Activity or Practice	Unit of Measure	Average Annual Amount in the First Decade
Hazardous Fuels Reduction	Fuels hazard mitigation activities including mechanical and prescribed fire fuel treatments	Acres per Year	8,000
Fuelbreaks	Creation and maintenance of fuelbreaks.	Acres per Year	2,000
Maintain and Improve Watershed Condition	Includes activities designed to: care for soil conditions, water quality and quantity; control timing of flows to sustain desired vegetation and soil condition to achieve forest, rangeland, and aquatic health; protect ecological values and function.	Acres per Year	100
Decommission Classified and Unclassified Roads	Activities include stabilizing and restoring unneeded roads to a more natural state.	Miles of road per year	20
Improve Transportation System - Roads	Activities include parking lot and campground spur construction as well and National Forest System road construction.	Miles of road per year	6
Improve Transportation System - Trails	This activity addresses capital improvement of new and existing system trails, trail bridges and associated appurtenances such as, signs, barriers, culverts, fencing, viewing platforms contiguous to the trail, etc.	Miles of trail per year	38
Establish Forest Vegetation	Activities including but not limited to planting, seeding, natural regeneration, site preparation designed to establish or reestablish desired vegetation to improve or maintain watershed health, forest and aquatic health, protect ecological values and improve the production of forest products and services.	Acres per Year	5,990
Improve Forest Vegetation	Activities include but are not limited to release, weeding, thinning, fertilizing and pruning designed to improve or maintain watershed health, forest and aquatic health, to protect ecological values and to improve the production of forest products and services.	Acres per Year	935

Oil and Gas

Forest Plan Standards and Guidelines classify oil and gas resource availability for leasing and subsequent development. Application of the Forest Plan Standards and Guidelines shows what lands may be considered available, and if available, under what condition. Many areas of the National Forest System lands are restricted through a no-surface-occupancy restriction; that is, the surface of the lands cannot be occupied for oil and gas drilling operations. These areas are precluded from occupancy due to values such as wetlands, Research Natural Areas, and experimental forests. Other areas are restricted through seasonal or timing restrictions. An example of this type of restriction is the restriction for Kirtland's warbler areas. In addition, there are "controlled use" restrictions. These limit development by stipulating how exploration may be done. The semiprimitive motorized and nonmotorized areas have a well density restriction of one surface location per 160 and 640 acres, respectively. Lands available for oil and gas leasing through application of the Forest Plan's Standards and Guidelines for all alternatives is summarized in Table D-7. Specific details of the Standards and Guidelines can be found in Chapter III-Management Area Direction.

Table D-7. Total Acres Available for Leasing by Lease Stipulation Category.

Lease Stipulation Category	Acres
Not Available	3,380
No-Surface Occupancy	204,631
Other Restrictions (total)	419,266
• Controlled Surface Use 1 well per 640 Acres	44,376
• Controlled Surface Use 1 well per 160 Acres	12,426
• Kirtland's Warbler Restriction	66,676
• Old Growth Restriction	86,952
• Wildlife Area/Karner Blue Butterfly	208,836
Standard Stipulations	345,257
Total National Forest System Lands	973,107

Oil and Gas - Reasonably Foreseeable Development Scenario

Introduction:

In conformance with regulations addressing the availability of federal oil and gas resources on National Forest System lands for leasing (36 CFR 228.102(c-e)), a reasonably foreseeable oil and gas development scenario has been developed for the next 10 to 15 year period. This report was prepared by Dave Lachance of the Bureau of Land Management, Milwaukee, Wisconsin and represents projections based on best available information.

This report is divided into three parts. Part I provides a general discussion of the five major field types found on the Forests. Part II provides the projections of anticipated development within the administrative boundaries of the Forests over the next 10-15 years purely from a geologic standpoint. Part III provides modified projections with consideration for the Forest Plan Standards and Guidelines.

The projected levels of oil and gas development provided by the reasonably foreseeable oil and gas development scenario under each Forest Plan Alternative are analyzed in the Final Environmental Impact Statement associated with the Forest Plan. This programmatic analysis supports a decision on availability of the federal oil and gas resource for leasing. The availability decision does not commit the resource to leasing and/or development. It simply documents what federal oil and gas would be considered available for leasing and specifies the conditions for surface occupancy. Upon completion of the revision process, if a request for leasing of specific lands is received, the Environmental Impact Statement will be reviewed, the assumptions validated, and if appropriate, the Forests will make a recommendation on “consent” to the Regional Forester. The Regional Forester will then advise the Bureau of Land Management as to whether these specific lands may be offered for lease, and if so, under what conditions (lease stipulations). Should the analysis in the Final Environmental Impact Statement not be adequate for this action, or if new information or changed conditions need to be considered, additional environmental analysis would be done prior to making a recommendation.

Part I: The General Setting in the Lower Peninsula:

The exploration for commercial accumulations of oil and gas revolves around attempting to locate porous and/or fractured, permeable reservoir rocks which contain oil and gas that has migrated into the reservoir rocks from source rocks and has been prevented from migrating further to shallower depths by the presence of impermeable formations above the reservoir rocks, and the presence of a trapping mechanism along the oil and gas’ migration path. Traps block the movement of oil and gas migrating through porous and permeable rock

Oil and gas production within the Lower Peninsula of Michigan is from sediments deposited in the Michigan Basin, a large depression in the Earth’s crust centered in the Lower Peninsula. Though commercial oil and gas production within the State of Michigan began in 1923, in general, oil and gas fields discovered within the state to date can be grouped into five major field types based upon the type of trap present within these fields. It is anticipated that exploration for oil and gas within the area being considered in this document will continue to center upon attempts to find undiscovered oil and gas fields which fit into these general categories. A brief description of each field type in the State follows.

Lower Tier, Mid-Michigan Rift-Related Fields:

A roughly northwest-southeast trending feature known as the Mid-Michigan Rift underlies the Lower Peninsula of Michigan. The Mid-Michigan Rift is related to a larger rift system known as the Mid-Continent Rift that has its northern terminus in the general vicinity of Duluth, Minnesota and passes southwest through central Iowa and eastern Kansas.

Formation of both the Mid-Michigan and the Mid-Continent rift systems began in the Pre-Cambrian Period. Both rift systems are widely believed to be “failed rifts” created as a result of normal faulting associated with plate tectonic movements within the Earth’s crust. They are “failed” only in the sense that the rifts did not become spreading centers similar to the Mid-Atlantic rift. Had the rifts become spreading centers, it is feasible that the North American continent would have been split into two major blocks and an open ocean comparable to the Atlantic Ocean would have formed.

The majority of movement along the Mid-Michigan rift faults probably ended at the beginning of the Ordovician Period, which coincides approximately with the deposition of the Prairie du Chien sandstone, considered by many scientists to be equivalent to the St. Peter sandstone. Faults in the Mid-Michigan rift tend to be aligned along three major axes: N 6 degrees W, N 47 degrees W, and N 64 degrees W, and many of the larger faults can be discerned by gravity and aeromagnetic data which has been compiled by various sources. Traps along these trends were formed by normal faulting, which prevented oil and gas from freely migrating through large areas of porous and permeable sedimentary rocks and caused it to accumulate in relatively small areas. Within the Huron-Manistee National Forests, Prairie du Chien gas production from the Mio Field (T25N, R3E, Oscoda County) is an excellent example of this type of Field.

Upper Tier, Mid-Michigan Rift-Related Fields:

After the beginning of the Ordovician Period, movement along faults associated with the Mid-Michigan rift significantly declined, and the majority of further movement along these faults tended to occur along the N 47 degrees W axis. Evidence has been found that movement along some of these faults has continued to occur on an irregular basis, but large-scale movement of these faults appears to have ceased by the end of the Devonian Period in most areas of the Lower Peninsula.

Traps along these trends were formed by normal faulting, which prevented oil and gas from freely migrating through large areas of porous and permeable sedimentary rocks and caused it to accumulate in relatively small areas. Upper Tier Fields are structurally related to the Lower Tier Fields discussed in the previous section in that they formed as a result of reactivation of faults associated with the Lower Tier Fields.

The presence of an Upper Tier Field has often been used to infer the presence of a Lower Tier Field, and the exploration for Prairie du Chien gas Fields has traditionally centered around exploration within existing shallow oil and gas fields. However, it is likely that undiscovered Lower Tier Fields exist within the Lower Peninsula that are not evidenced by shallower Upper Tier traps.

Within the Huron-Manistee National Forests, Richfield oil and gas production from the Mio Field (T25N, R3E, Oscoda County) is an excellent example of this type of Field.

Salina-Niagaran Pinnacle Reef Fields:

Pinnacle Reefs are not unique to Michigan, but are found in two narrow, arcuate bands within the Lower Peninsula. One band is present along the southern end of the peninsula. The other band is located at the northern and western part of the peninsula; passing through a small section of the Manistee National Forest in western Manistee, Mason and Oceana Counties. Though numerous reefs are present within these bands, not all of the reefs contain oil and gas, and exploratory dry holes are common. Further, the part of the band passing through Mason and Oceana Counties is lightly populated with reefs.

The reefs were formed during the Silurian Period and are widely regarded as having been formed by reef-forming organisms which grew upward in equilibrium with downward movement of the Michigan Basin. Oil and gas has also accumulated in porous and permeable space within the reefs, and in sediments draped over their crests. Reef sizes vary, but are generally within 160 to 360 acres in size. Potential reefs are usually located by running seismic tests.

Within the Huron-Manistee National Forests, gas production from the Grant 32-20N-17W Field (T20N, R17W, Section 32) is an excellent example of this type of field.

Salt-Related, Shallow Structure Fields:

In the western half of the Lower Peninsula, leaching of the Salina A-1 salt, a Silurian-aged formation which is also found draped over Pinnacle reefs, led to the fracturing and slumping of overlying carbonates; creating structural features over which sediments being deposited in the Michigan Basin were subsequently draped over. Sediment draping generally continued throughout the Devonian Period and bioherms, a general term for localized accumulations of algal mats, solitary reefs and other associated fauna, formed on many of these features and formed localized structural highs. The size and shape of these fields varies considerably, and prospective exploration targets have usually been found through seismic, analysis of subsurface data and gravity data.

Within the Huron-Manistee National Forests, oil production from the abandoned Cherry Grove Field (T21N, R10W, Section 27) is an example of this type of field.

Antrim Shale Fields:

The Antrim Shale has been a widespread, ongoing exploration target within the upper part of the northern Lower Peninsula since the late 1980s. The shale is present beneath broad areas of the Lower Peninsula, and Antrim Shale Fields actually consist of contiguous blocks of land which have been leased by a specific company and unitized to form a continuous drilling block capable of supporting a group of wells serviced by central gas processing and water disposal facilities. Blocks of unitized lands are referred to as Units.

Production from the Shale has occurred for decades, but a combination of tax incentives, the relatively low dry hole risk associated with drilling Antrim wells, the increased demand for gas

as opposed to oil to fuel power plants, low drilling and completion costs, and consistent production from these wells has made the Antrim a popular exploration target.

The Antrim Shale is a classic black shale reservoir in that it contains a high organic content, is highly fractured, and is believed to be its own source and reservoir bed. Gas is produced from fractures within the Shale.

Early speculation regarding the Shale's potentially productive area led to the common belief that much of the northern half of the Lower Peninsula would eventually be drilled to support Antrim gas production. However, this assumption has since proven inaccurate and, though the Huron-Manistee National Forests can expect some drilling of Antrim wells within the Forests, most of these wells will be confined to its northern borders. Additional Antrim Shale exploration is occurring in the southern end of the peninsula, but to date the results of exploration in this part of the peninsula have not been encouraging.

Though drilling for the Antrim Shale has occurred within the boundaries of the Huron-Manistee National Forests, the results have been discouraging to operators who have drilled within most of the area. However, numerous examples of Antrim Shale Fields can be found north of the Forests and, in some places, successful field development is occurring within several miles of its northern boundaries. Recent state well permit applications have been approved on private minerals within the Forests' boundary.

Part II: Prognostications:

Estimates of the number of wells that are likely to be drilled within the boundaries of a specific area over a specific time interval are at best speculative. However, such numbers can be reasonably estimated by using past general trends. Further, while specific locations likely to experience drilling can only rarely be predicted, general areas likely to attract drilling for specific target types can be broadly outlined with reasonable confidence and the number of wells needed to explore a generic target can be estimated by using existing oil and gas fields as a model for their development.

Estimates of the number, type and general location of exploratory and development wells likely to be drilled within the Huron-Manistee National Forests is given in this section. For ease of analysis, the estimates are given for the Huron and the Manistee National Forests separately. Though estimates made by individuals will vary, estimates made by large numbers of people will probably fall within a very narrow bell curve. All estimates given below were made as the result of geologic evaluations of data available to Dave Lachance of the Bureau of Land Management's Milwaukee Field Office Staff.

Huron National Forest:

Future exploration and development within the Huron National Forest is likely to be confined to Lower and Upper Tier, Mid-Michigan Rift-Related Fields and Antrim Shale Fields. The following assessments of where exploration for these types of targets is likely to occur are based

upon all available data at the time this reasonably foreseeable oil and gas development scenario was written.

Huron, Lower Tier, Mid-Michigan Rift-Related Potential:

Exploration for Lower Tier, Mid-Michigan Rift-Related fields has traditionally centered upon drilling within the boundaries of established or seismically discernable Upper Tier fields; effectively looking for deeper production along the faults that are indirectly associated with the upper tier fields. These efforts have been further augmented by the use of gravity and magnetic data by some exploration companies to define and refine potential Lower Tier targets. Use of these latter tools centers upon looking for sharp changes in gravity and magnetic data that may indicate the vertical displacement of basement rocks, and consequently the presence of a fault that may extend into the sediments overlying the basement.

As this report is being written, Lower Tier exploration has been proposed in Crawford County, Sections 7, T25N, R1W. If drilled, the proposed well is expected to target a gas accumulation associated with a northwest-southeast trending fault that transects the northern third of the township. If successful, it is anticipated that additional wells would be drilled that fall along the general trend of this fault.

Additional untested, plausible but not certain, Lower Tier, moderate potential exploration targets have been delineated and are centered upon the following areas:

- Iosco County, T22N, R6E, Section 12.
- Iosco County, T23N, R5E, Section 13.
- Crawford County, T25N, R1W, Section 36.
- Alcona County, T25N, R6E, Section 19.
- Oscoda County, T26N, R1E, Section 35.

All other lands within the Forest's boundaries have a low potential for Lower Tier exploration targets.

Exploration of a Lower Tier target can result in the drilling of one well if the well is dry or sub-economic, or approximately five to ten wells for a gas-filled feature. Assuming each postulated structure has a 50 percent chance of containing commercial gas, full exploration of the untested features and the currently planned well in Section T25N, R1W, would probably result in three dry holes and three discoveries. Each of the three discoveries would support a total of three to seven wells, or a total of nine to twenty one gas wells that would probably be drilled on a 640-acre spacing and the orientation of the fields would generally be in a northwest-southeast direction.

A summary of the number of Lower Tier wells that can reasonably be expected to be drilled within the boundaries of the Huron National Forest is shown in Table D-8.

Table D-8. Target: Lower Tier Wells - Huron National Forest.

	Minimum	Maximum	Most Likely
Total Number of Wells	1	27	15
Dry Hole	1	3	3
Producing	0	24	12

Upper Tier, Mid-Michigan Rift-Related Potential:

Exploration for Upper Tier, Mid-Michigan Rift-Related fields within the forest's boundaries will depend upon a willingness to acquire additional seismic surveys within the forest, and reprocessing of old seismic lines that are available, to detect subtle shallow untested structures. Upper Tier structures are formed by reactivation of faults responsible for the formation of Lower Tier structures. Consequently, decisions to acquire and reprocess seismic data could logically be driven by evidence of Lower Tier structures that can be discerned from magnetic and gravity data. However, the existence of a Lower Tier structure does not guarantee that there will be a corresponding Upper Tier structure associated with a Lower Tier structure.

With the above analysis in mind, it is reasonable to deduce that Upper Tier structures may be associated with the Lower Tier structures that have been described in the previous section of this reasonably foreseeable oil and gas development scenario. Consequently, additional untested, plausible but not certain, Upper Tier, moderate potential exploration targets have been delineated and are centered upon the following areas:

- Iosco County, T22N, R6E, Section 12.
- Iosco County, T23N, R5E, Section 13.
- Crawford County, T25N, R1W, Section 36.
- Alcona County, T25N, R6E, Section 19.
- Oscoda County, T26N, R1E, Section 35.

All other lands within the Forest's boundaries have a low potential for Upper Tier exploration targets.

Exploration of an Upper Tier exploration target can result in the drilling of one well if the well is dry or sub-economic, or approximately ten to fifteen wells for an oil-filled feature. Assuming each postulated structure has a 20 percent chance of containing commercial oil, full exploration of the untested features would probably result in four dry holes and one discovery. The discovery would support a total of ten to fifteen wells that would probably be drilled on a 40-acre spacing, and the orientation of the fields would generally be in a northwest-southeast direction.

Additional exploration on these types of structures could consist of exploration for "bypassed gas and/or oil" and/or deeper, untested zones in structures that have been delineated by earlier drilling.

Bypassed gas and/or oil consists of producible gas and/or oil that was uneconomical to produce when it was initially encountered in wells drilled in an area, but is now likely to be commercially

producible if new drilling was undertaken. However, no solid evidence exists that such exploration is occurring within the Huron on a significant basis, and consequently the likelihood of such exploration occurring in the foreseeable future is considered to be negligible.

A summary of the number of Upper Tier wells that can reasonably be expected to be drilled within the boundaries of the Huron National Forest is shown in table D-9.

Table D-9. Target: Upper Tier Wells – Huron National Forest.

	Minimum	Maximum	Most Likely
Total Number of Wells	0	19	14
Dry Hole	0	4	4
Producing	0	15	10

Huron, Antrim Shale Potential:

Antrim Shale development is occurring steadily north of the Forest's boundary, but extensive development is not expected on the Forest. Potential for Antrim development decreases from north to south throughout the Forest.

It is anticipated that, for the foreseeable future, there is a high potential for Antrim Shale exploration and development within the Forest Boundary in T28N, R9E, and in the northern half of T27N, R9E. If any additional wells are drilled outside of the high potential area, they will most likely be located in T27N, R4E through 8E inclusive, and the southern half of T27N, R9E. These lands have low to moderate potential for Antrim Shale exploration. There have been at least six Antrim wells drilled within the Forest's administrative boundary T27N, R4-8E that have resulted in either dry holes and/or plugged wells. All lands south of T27N have low potential for Antrim Shale exploration.

In recent years, only seven Antrim wells have been drilled in the high potential area within the Forest's boundary and no additional drilling is scheduled to take place although there are existing untested leases in this area (Note: Two Federal Applications for Permit to Drill were received during 2005 for lands in T28N, R9E). In addition, there have been recent nominations for additional leasing. All of the prior wells were drilled on non-Federal land with four being plugged and three are currently listed as "shut-in." Assuming some additional drilling occurs in the high potential area, a summary of Antrim wells that can reasonably be expected to be drilled within the boundaries of the Huron National Forest is shown in table D-10.

Table D-10. Target: Antrim Shale – Huron National Forest.

	Minimum	Maximum	Most Likely
Total Number of Wells	1	40	24
Dry Hole/Subeconomic	1	8	5
Producing	0	32	19

These estimates are based on the assumption that two Antrim Units would be established within the administrative boundary of the Forest. Of the total wells drilled, 20 percent would be dry holes or uneconomic. Each well would produce gas and be connected to a gathering line. Gas

produced from each Unit would be processed at one central processing facility. All formation water would be disposed of in a water disposal well drilled somewhere within the Units' boundaries.

Manistee National Forest:

Future exploration and development within the Manistee National Forest is likely to run the gamut of all exploration types present within the State of Michigan; Lower and Upper, Mid-Michigan Rift-Related Fields, Salina-Niagaran Pinnacle Reef Fields, Salt Related Shallow-Structure Fields and Antrim Shale Fields. The following assessments of where exploration for these types of targets is likely to occur are based upon all available data at the time this reasonably foreseeable oil and gas development scenario was written.

Manistee, Lower Tier, Mid-Michigan Rift-Related Potential:

Exploration for Lower Tier, Mid-Michigan Rift-Related fields has traditionally centered upon drilling within the boundaries of established or seismically discernable Upper Tier fields; effectively looking for deeper production along the faults that are indirectly associated with the upper tier fields. These efforts have been further augmented by the use of gravity and magnetic data by some exploration companies to define and refine potential Lower Tier targets. Use of these latter tools centers upon looking for sharp changes in gravity and magnetic data that may indicate the vertical displacement of basement rocks, and consequently the presence of a fault that may extend into the sediments overlying the basement.

As this report is being written, Lower Tier exploration is occurring in Newaygo County, Section 13, T.13N., R.12W., and Section 28, T.15N., R.11W. Both wells are redrills of dry and abandoned wells that were drilled to test the same formations currently being evaluated. Collectively, this current drilling effort is expected to lead to further drilling of two to six gas wells.

Unlike the Huron National Forest, as of the date of this report, the area containing the Manistee National Forest has not been evaluated in sufficient detail to determine site-specific, plausible, moderate potential exploration targets. Further, the Manistee National Forest area experienced extensive drilling for Lower Tier exploration targets during the 1980s and early 1990s. Collectively, the Manistee National Forest area has a low potential for attracting Lower Tier exploration, but several untested Lower Tier targets undoubtedly exist within the Forest's boundaries and will attract exploration.

In general, any area underlain by an Upper Tier structure that has not been experienced Lower Tier exploration will probably be drilled at some time in the indefinite future. Assuming a steady rate of exploration within the Forest's boundaries, it is anticipated that four additional Lower Tier wells will be drilled on a 640-acre spacing within the foreseeable future. Each will have a 50 percent chance of being dry. Each successful discovery will lead to drilling a total of three to seven wells per gas field, and the gas fields will most likely be drilled on a northwest-southeast orientation.

A summary of the number of Lower Tier wells that can reasonably be expected to be drilled within the boundaries of the Manistee National Forest follows:

Table D-11. Target: Lower Tier Wells – Manistee National Forest.

	Minimum	Maximum	Most Likely
Total Number of Wells	2	19	13
Dry Hole	2	6	4
Producing	0	13	9

Manistee, Upper Tier, Mid-Michigan Rift-Related Potential:

All of the lands within the boundaries of the Manistee National Forest in Lake, Mason, Muskegon, Newaygo and Oceana Counties have moderate potential for attracting exploration for Upper Tier, Mid-Michigan Rift-Related Structures. All other lands within the boundaries of the Forest have low potential for attracting such exploration.

Exploration for Upper Tier, Mid-Michigan Rift-Related fields within the Forest Boundaries will depend upon a willingness to acquire additional seismic surveys within the Forest, and reprocessing of old seismic lines that are available, to detect subtle shallow untested structures and attempts to locate “bypassed gas and/or oil.”

Upper Tier structures are formed by reactivation of faults responsible for the formation of Lower Tier structures. Consequently, decisions to acquire and reprocess seismic information could logically be driven by evidence of Lower Tier structures that can be discerned from magnetic and gravity data. However, the existence of a Lower Tier structure does not guarantee that there will be a corresponding Upper Tier structure.

Bypassed gas and oil consists of producible hydrocarbons that were uneconomical to produce when it was initially encountered in wells drilled in an area, but is now likely to be commercially producible if new drilling was undertaken.

Lake, Mason, Muskegon, Newaygo and Oceana Counties are peppered with wells which were drilled in the 1940s, the 1950s and later years which were completed as dry holes but had encountered noncommercial gas. Identifying wells that have bypassed gas is usually a painstaking process involving searching for scant records and well data from diverse data-sources. Consequently, deducing the feasibility of extracting commercial gas by new drilling within any given area can be more of an art than a science. The potential for deeper untested zones often act as an additional inducement to drill in an area which may contain bypassed gas and/or oil, but well data for deeper, older wells tends to be relatively scarce, and any exploration efforts for such production is forced to rely upon inferring deeper potential using shallower data.

Although numerous examples of potential areas of land underlain by bypassed gas and oil production are present within the moderate potential area described, delineating specific prospects likely to draw exploration is beyond the scope of this reasonably foreseeable oil and gas development scenario due to lack of data and the level of effort that would be involved in evaluating the data if it were available. Full analysis would require the evaluation of every

shallow dry hole drilled in the area. However, at the time this report is being written, active exploration for bypassed gas and/or oil appears to be taking place in several places within the Forest in the following general areas:

- Lake County, T.18N., R.14W, Sections 14 and 24, Wildcat, Stray Sand.
- Newaygo County, T.14N., R.11W., Section 4, Huber Field, Traverse Limestone.
- Newaygo County, T.14N., R.14W., Section 5, Huber Field, Marshall Sand.
- Newaygo County, T.15N., R.11W., Section 28, Woodville Field, Traverse Limestone.
- Newaygo County, T.15N., R.11W., Section 28, Woodville Field, Richfield.
- Oceana County, T.15N., R.16W., Section 25, Filer Sand.

These exploration efforts serve as excellent examples of the type of exploration that are likely to occur as part of efforts to explore these types of structures.

Exploration of newly recognized, and known Upper Tier exploration targets can result in the drilling of one well if the well is dry or sub-economic, or approximately 10 to 15 wells for an oil and/or gas-filled feature. Assuming an aggressive drilling program of one exploratory well on twenty such features within the Manistee National Forest, and that each such structure has a 20 percent chance of containing commercial oil and/or gas, this would result in 16 dry holes and four discoveries. Each discovery would support a total of 10 to 15 wells that would probably be drilled on a 40-acre spacing, and the orientation of the fields would generally be in a northwest-southeast direction.

A summary of the number of Upper Tier wells that can reasonably be expected to be drilled within the boundaries of the Manistee National Forest is shown in Table D-12.

Table D-12. Target: Upper Tier Wells - Manistee National Forest.

	Minimum	Maximum	Most Likely
Total Number of Wells	1	76	56
Dry Hole	1	16	16
Producing	0	60	40

Manistee, Salina-Niagaran Pinnacle Reef Potential:

Exploration for Pinnacle Reefs is heavily dependent upon acquisition of new seismic data, and the reprocessing older seismic data with new analytical methods. Without such data, drilling for these reefs would be essentially a shot in the dark due to the fact that they have no known structural expression at depth and are only reflected at slightly shallower depths by drape of sediments over the reefs.

Pinnacle Reefs are routinely explored with directional drilling. Consequently, access to the surface overlying these reefs is not crucial to their complete development. However, access to the surface overlying the reefs is crucial for the purposes of seismic acquisition.

Postulating precise exploration targets within the Pinnacle Reef trend is beyond the capability of the Bureau of Land Management, but identifying general areas where exploration may occur is.

All lands within the National Forest Boundaries inside the following areas (Table D-13) have a moderate potential for Pinnacle Reef exploration, but potential for such exploration decreases dramatically from north to south, and most of such exploration is likely to occur in Manistee County. All other areas within the Forest Boundaries have essentially no potential for Pinnacle Reef exploration.

Table D-13. Moderate Potential for Pinnacle Reef Exploration Locations.

Manistee County	T.23N., R13W.	Western Half Within Forest Boundaries
	T.22N., R14W.	All Within Forest Boundaries
	T.22N., R15W.	
	T.21N., R15W.	
	T.21N., R15W.	
Mason County	T.20N., R15W.	All Within Forest Boundaries
	T.20N., R16W.	
	T.20N., R17W.	
	T.20N., R18W.	
	T.17N., R16W.	
	T.17N., R18W.	
Oceana County	T.16N., R16W.	All Within Forest Boundaries
	T.16N., R17W.	
	T.14N., R16W.	
	T.14N., R17W.	

Few reefs are located in the areas described above, and many of the wells which have been drilled to explore these reefs have been dry. Based upon available data, the maximum foreseeable development of Pinnacle Reef wells would be 7 wells on an 80-acre spacing. A more likely scenario would be drilling of four Pinnacle Reef wells. Most will be dry, but others will produce oil or gas. Assuming a 25 percent success rate a summary of the number of wells, which can be expected to be drilled within the boundaries of the Manistee National Forest follows:

Table D-14. Target: Pinnacle Reefs – Manistee National Forest.

	Minimum	Maximum	Most Likely
Total Number of Wells	1	7	4
Dry Hole	1	5	3
Producing	0	2	1

Manistee, Salt-Related, Shallow Structure Potential:

All of the lands within the boundaries of the Manistee National Forest in Mason, Muskegon and Oceana Counties, and the western halves of Lake and Newaygo Counties have moderate potential for attracting exploration for Salt-Related, Shallow Structures. All other lands within the boundaries of the Forest have low potential for attracting such exploration.

The majority of the wells drilled for these types of structures is expected to target “bypassed gas

and oil” and/or deeper, untested zones in structures which have been delineated by earlier drilling.

Bypassed gas and oil consists of producible hydrocarbons that were uneconomical to produce when it was initially encountered in wells drilled in an area, but is now likely to be commercially producible if new drilling was undertaken.

Mason, Muskegon and Oceana Counties, and the western half of Lake and Newaygo Counties are peppered with wells which were drilled in the 1940s, the 1950s and later years which were completed as dry holes, but had encountered noncommercial gas. Identifying wells that have bypassed gas is usually a painstaking process involving searching for scant records and well data from diverse data-sources. Consequently, deducing the feasibility of extracting commercial gas by new drilling within any given area can be more of an art than a science. The potential for deeper untested zones often act as an additional inducement to drill in an area which may contain bypassed gas, but well data for deeper, older wells tends to be relatively scarce, and any exploration efforts for such production is forced to rely upon inferring deeper potential using shallower data.

Although numerous examples of potential areas of land underlain by bypassed gas production are present within the moderate potential area described, delineating specific prospects likely to draw exploration is beyond the scope of this reasonably foreseeable oil and gas development scenario due to lack of data and the level of effort that would be involved in evaluating the data if it were available. Full analysis would require the evaluation of every shallow dry hole drilled in the area. However, at the time this report is being written, a 2002 discovery known as the Spruce Field, also known as the Yates Field, is an excellent example of this type of field and exploration efforts which are likely to be driven by the presence of bypassed gas.

The Yates Field is subject to a special spacing order that establishes 80-acre drilling units formed by combining two governmental surveyed quarter-quarter sections of land, except for the discovery well which is spaced at 40 acres. The spacing interval includes all stratigraphic intervals lying within the Dundee Limestone Formation. Under the spacing order the Field is defined as:

Lake County, Michigan
Michigan Meridian
T.17N., R.12W.,
Section 21, E2SE, S2NE;
Section 22, SW, S2NW, NENW, SWSE;
Section 27, W2, W2NE, W2SE;
Section 28, E2NE, E2SE.

Assuming full development takes place, the Spruce Field has room for 12 wells. Two of the 12 wells have already been drilled and are producing. It is predicted that there may be up to an additional 10 wells drilled of which 60 percent (6) will probably be commercial gas and/or oil wells. The remaining 40 percent (4) are likely to be dry holes.

Numerous, large and small structures similar to the structure supporting the Yates Field probably exist within the area on the Manistee National Forest, considered to have moderate potential for

exploration. A smaller number of structures probably exist within the low potential area of the Manistee National Forest. However, it is extremely unlikely that all of them would be explored within the foreseeable future. Further, due to scarce and limited data, it is unlikely that every exploratory well that is drilled to evaluate these types of fields is likely to lead to a commercial discovery. Rather, it is anticipated that approximately 60 percent of such wells are likely to encounter noncommercial gas and/or oil which may be considered bypassed gas and/or oil at some point in the indefinite future, 20 percent of the wells are likely to be dry with no gas discovered, and 20 percent of such wells will lead to a commercial discovery that warrants further development.

For the foreseeable future, in addition to the 10 wells expected to be drilled in the Yates Field, an aggressive exploratory drilling program designed to evaluate structures similar to the Yates structure, would probably test 10 features within the Manistee National Forest. Based upon the above assumptions, six wells will encounter noncommercial gas and/or oil that fail to warrant further development, two wells will be dry, and two wells will lead to further development. Assuming the Yates Field is an average sized field, full field development of the additional two gas/oil discovery wells would result in drilling 24 additional wells, or a total of 12 wells per new gas/oil field. A more plausible exploratory plan would result in testing only five such features, leading to half the number of wells.

A summary of the number of wells which can be expected to be drilled on these lands is shown in table D-15.

Table D-15. Target: Salt-Related, Shallow Structure Fields - Manistee National Forest.

	Minimum	Maximum	Most Likely
Total Number of Wells	3	44	27
Dry Hole	0	20	12
Producing	3	24	15

Antrim Shale Potential:

Antrim Shale development is occurring steadily along the extreme northwestern area of the Forest's boundary, but is not expected to significantly impact the Forest. Potential for Antrim development decreases from north to south throughout the Forest.

It is anticipated that, for the foreseeable future, there is moderate to high potential for Antrim Shale development within the Forest Boundary within T22 and 23 N., R13, 14 and R15W. The remainder of the Forest has low potential for isolated, sporadic, and probably economically unsuccessful Antrim wells.

Though state spacing for Antrim wells is 80 acres, Antrim Units are often drilled on a one well per 160-acre spacing with additional wells drilled if warranted. An Antrim drilling unit typically includes 12-20 wells and covers an area of approximately 4-6 sections. Full development is predicated upon such development being economically warranted, such as: the results of one well invariably influences a decision to drill the next well and exploration expectations for a

large area are rarely met or exceeded when wells are actually drilled. For purposes of this analysis, we will assume that there is potential for development of four drilling units within the moderate to high development potential area. This could result in drilling 48 to 80 wells. Assuming 80 percent of these wells will be economic/productive, this would result in a total of 38 to 64 producing wells.

To date only one Antrim well has been drilled in the area described. Though this leaves ample room for Antrim development, its pace is expected to be relatively slow within this area.

A summary of the number of Antrim wells that can reasonably be expected to be drilled within the boundaries of the Manistee National Forest follows:

Table D-16. Target: Antrim Shale - Manistee National Forest.

	Minimum	Maximum	Most Likely
Total Number of Wells	5	80	48
Dry Hole	5	16	10
Producing	0	64	38

All of these wells would become part of multi-well Antrim projects. Each well would produce gas and be connected to a gathering line. Gas produced from the project would be processed at a central processing facility. All formation water would be disposed of in a water disposal well drilled somewhere within the project's boundaries.

Summary:

The following tables summarize the foreseeable development by productive formation for each Forest. The following must be considered when using this information:

- The projections are based on best information available to the authors.
- The numbers reflect possible development within the administrative boundaries of each Forest. Foreseeable development, as depicted in these tables, is not limited to National Forest System lands.
- These projections do not consider existing Forest Plan Standards and Guidelines which further restrict surface occupancy. These numbers are based strictly on geologic potential.

Table D-17. Total Number of Wells Expected to be Drilled/Productive - Huron National Forest.

Type of Well	Minimum	Maximum	Most Likely
Lower Tier, Rift-Related	1/0	27/24	15/12
Upper Tier, Rift-Related	0/0	19/15	14/10
Pinnacle Reefs	0/0	0/0	0/0
Salt-Related, Shallow	0/0	0/0	0/0
Antrim Shale	1/0	40/32	24/19
Total	2/0	86/71	53/41

Table D-18. Total Number of Wells Expected to be Drilled/Productive - Manistee National Forest.

Type of Well	Minimum	Maximum	Most Likely
Lower Tier, Rift-Related	2/0	19/13	13/9
Upper Tier, Rift-Related	1/0	76/60	56/40
Pinnacle Reefs	1/0	7/2	4/1
Salt-Related, Shallow	3/3	44/24	27/15
Antrim Shale	5/0	80/64	48/38
Total	12/3	226/163	148/103

Part III - Prognostications with Consideration for the Forest Plan's Standards and Guidelines:

In an effort to better define how the Forest Plan's Standards and Guidelines may affect actual development on the ground (that is lease stipulations), the areas of moderate and high potential were compared to the existing constraints on surface use as outlined in the Standards and Guidelines. Based on this comparison, it was determined that the only area where foreseeable development may change because of these constraints was in the Antrim development on the Huron National Forest. The area identified as high potential for Antrim contains many wet areas and a Potential Candidate Research Natural Area in Alternatives B and C. These areas are identified as "no-surface-occupancy" and the actual number of wells that may be drilled is less than if these areas were unconstrained. Based on this evaluation, revised tables are presented below:

Table D-19. Total Number of Wells Expected to be Drilled/Productive Within the Huron National Forest Boundary Constrained by Standards and Guidelines.

Type of Well	Minimum	Maximum	Most Likely
Lower Tier, Rift-Related	1/0	27/24	15/12
Upper Tier, Rift-Related	0/0	19/15	14/10
Pinnacle Reefs	0/0	0/0	0/0
Salt-Related, Shallow	0/0	0/0	0/0
Antrim Shale	1/0	28/22	17/14
Total	2/0	74/61	46/36

Table D-20. Total Number of Wells Expected to be Drilled/Productive Within the Manistee National Forest Boundary Constrained by Standards and Guidelines.

Type of Well	Minimum	Maximum	Most Likely
Lower Tier, Rift-Related	2/0	19/13	13/9
Upper Tier, Rift-Related	1/0	76/60	56/40
Pinnacle Reefs	1/0	7/2	4/1
Salt-Related, Shallow	3/3	44/24	27/15
Antrim Shale	5/0	80/64	48/38
Total	12/3	226/163	148/103

The above tables provide an estimate of the total wells projected within the Forests' administrative border. Forest Plan Standards and Guidelines, or development constraints, apply

only to federal wells drilled on National Forest System lands. We will attempt to negotiate with potential operators to apply these Standards and Guidelines to operations involving private or state minerals on National Forest System lands. However, because our control over this type of development is more limited, imposition of the Standards and Guidelines is a negotiated element of any proposed mineral operations on severed mineral estates.

The next step is to determine what development could potentially occur on National Forest System land versus what will occur within the boundary. The percentage of National Forest System land within the administrative boundary on the Huron National Forest is approximately 63 percent and the percentage on the Manistee National Forest is approximately 40 percent. These figures will be used to calculate the foreseeable development on National Forest System lands. Because the analysis contained in the Forest Plan Environmental Impact Statement will be based on the “most likely” scenario, calculations from this point on will focus on those numbers.

Table D-21. Projection of Wells on National Forest System Lands.

Forest	Percentage of NFS Lands in Boundary	Total Wells Drilled/Productive in Boundary	Total Wells Drilled/Productive on NFS lands
Huron	63%	46/36	29/23
Manistee	40%	148/103	59/41
Total		194/139	88/64

To further refine these estimates, one needs to consider that some of these wells will be drilled into Federal mineral interest, from which the Federal Treasury and local counties will derive revenues, and some of the wells will be drilled on private or State mineral interest located beneath National Forest System lands. A weighted average of the mineral ownership data across the Forests shows that approximately 61 percent of the mineral ownership under National Forest System lands is in the private or state mineral category. Of the 88 wells drilled, it can be expected that approximately 54 of those will be drilled on private or state mineral interest and 34 will be drilled into federal mineral estate. Of the 64 productive wells, it is estimated that 39 of these will be producing private or state mineral interest and 25 will be producing federal minerals.

Based on the projected development outlined above, the total acreage disturbed over the next 10 to 15 years was calculated. These numbers are summarized in the table below:

Table D-22. Summary of Disturbance – Oil and Gas Reasonably Foreseeable Development Scenario.

Scenario	Total Wells Drilled	Total Wells Productive	Acres for Wellpads	Acres for Production Facilities	Acres for Pipeline	Acres for Access Road	Total Acres Initial Disturbance
Within Forests' Boundary	194	139	371	54	208.5	139	772.5
On National Forest System Lands	88	64	170	54	96	64	384

To some extent, historical drilling activity can be a predictor of what may occur in the future. In analyzing drilling permits/approvals between 1987 and 2003 on the Forests, there were a total of 80 wells permitted/approved. Of those 80 wells, 39 were Federal wells and 41 were drilled into private or state minerals beneath National Forest System lands. Given the fact that the Michigan Basin has been extensively drilled over the past century and the discovery of any major new plays is somewhat remote, the projections identified above seem realistic. Should a new play be discovered and the threshold of the analysis be exceeded due to an unexpected increase in drilling activity, additional environmental documentation and analysis would be necessary prior to any recommendations on consent.

All maps showing Standards and Guidelines and development potential can be found in the project file at the Huron-Manistee National Forests' Supervisor's Office, Cadillac, Michigan.